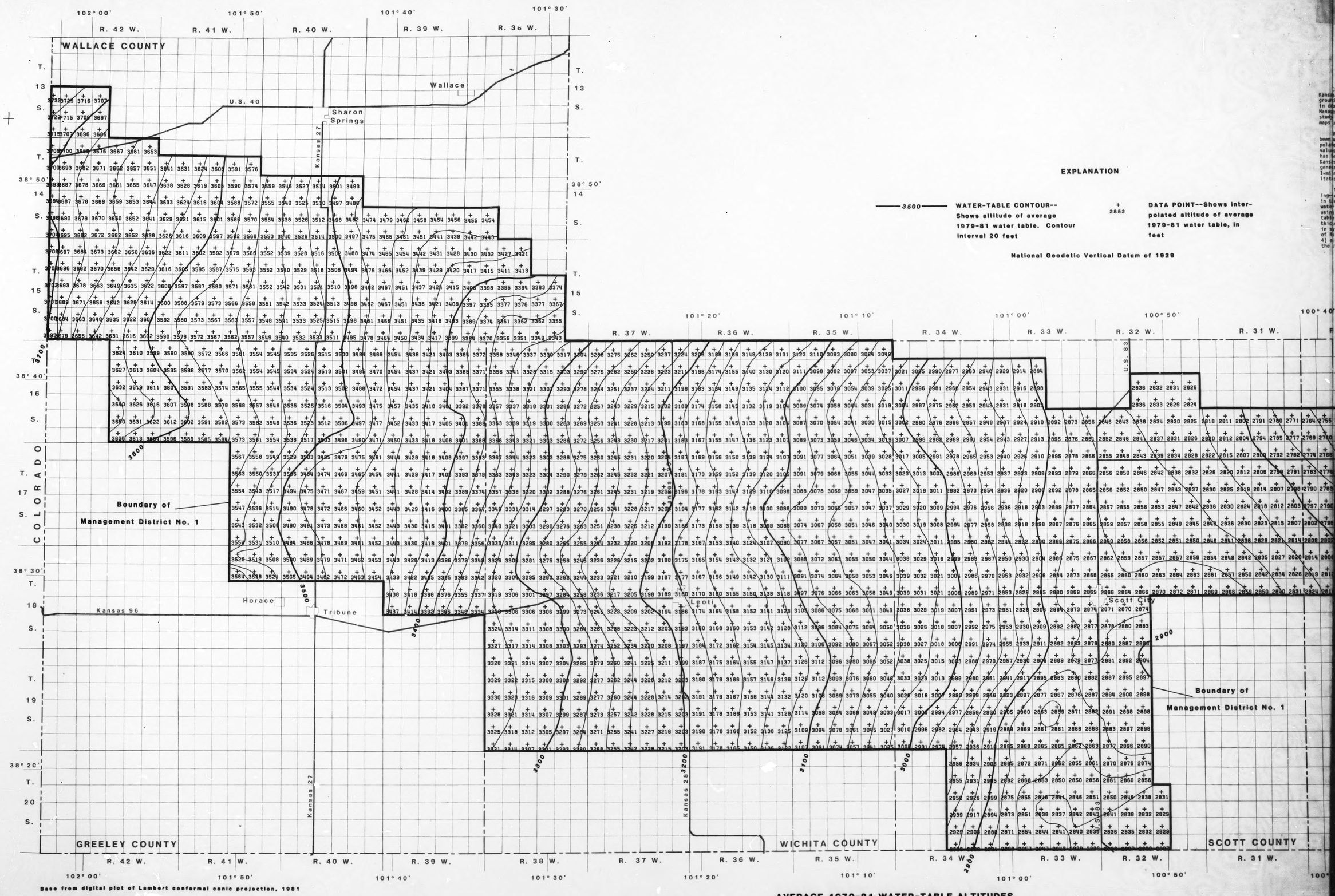
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
WESTERN KANSAS GROUNDWATER MANAGEMENT DISTRICT NO. 1



EXPLANATION

3500 — **WATER-TABLE CONTOUR--** Shows altitude of average 1979-81 water table. Contour interval 20 feet

\+ 2852 **DATA POINT--Shows interpolated altitude of average 1979-81 water table, in feet**

National Geodetic Vertical Datum of 1929

Base from digital plot of Lambert conformal conic projection, 1981

AVERAGE 1979-81 WATER-TABLE ALTITUDES

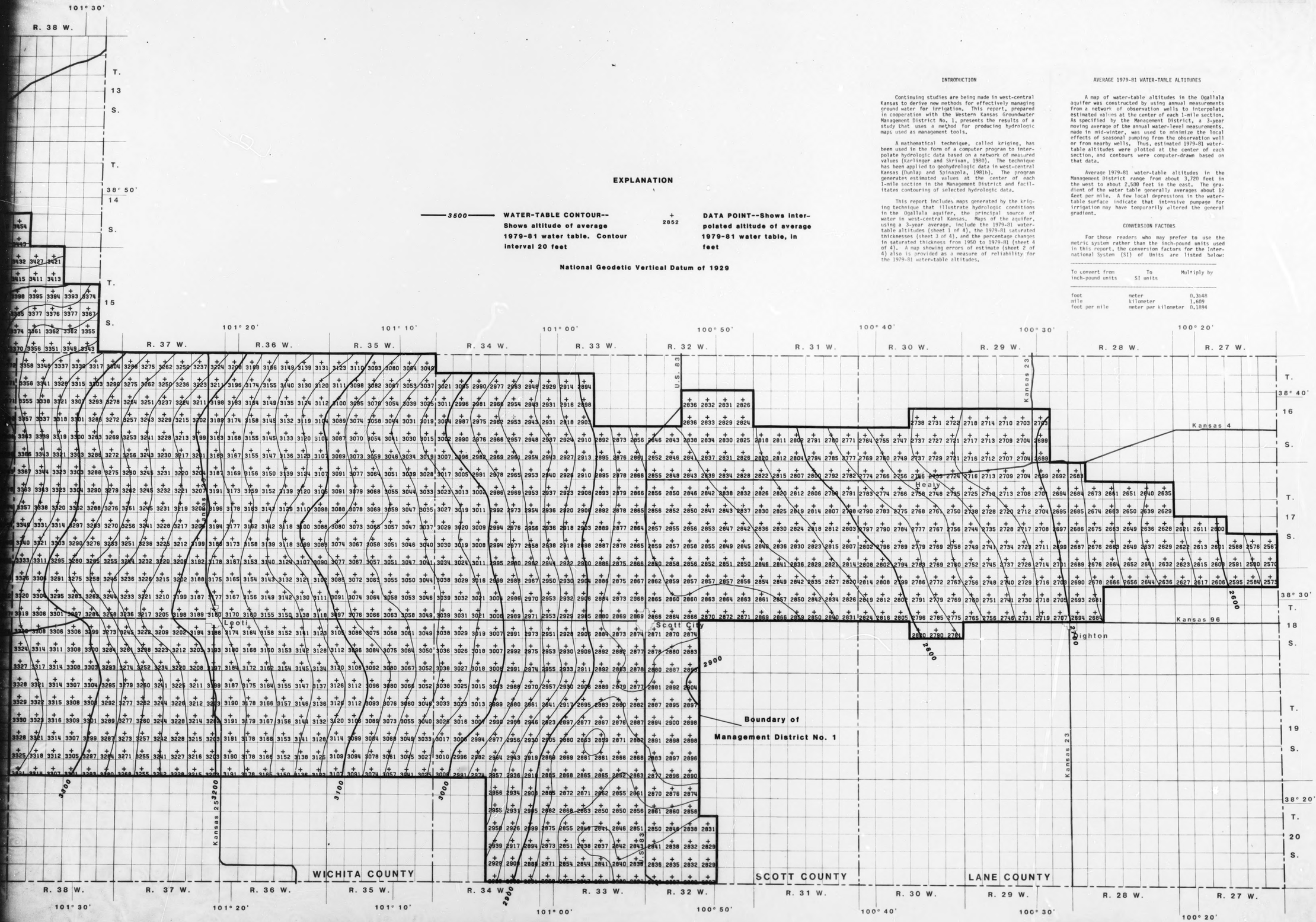
HYDROLOGIC MAPS OF OGALLALA AQUIFER, WEST-CENTRAL KANSAS, 1979-81

By

Joseph M. Spinazola

1982

Prepared in cooperation with the
WESTERN KANSAS GROUNDWATER MANAGEMENT DISTRICT NO. 1



EXPLANATION

3500 — WATER-TABLE CONTOUR--Shows altitude of average 1979-81 water table. Contour interval 20 feet

+ 2852 DATA POINT--Shows interpolated altitude of average 1979-81 water table, in feet

National Geodetic Vertical Datum of 1929

INTRODUCTION

Continuing studies are being made in west-central Kansas to derive new methods for effectively managing ground water for irrigation. This report, prepared in cooperation with the Western Kansas Groundwater Management District No. 1, presents the results of a study that uses a method for producing hydrologic maps used as management tools.

A mathematical technique, called kriging, has been used in the form of a computer program to interpolate hydrologic data based on a network of measured values (Karlinger and Skrivan, 1980). The technique has been applied to geohydrologic data in west-central Kansas (Dunlap and Spinazola, 1981b). The program generates estimated values at the center of each 1-mile section in the Management District and facilitates contouring of selected hydrologic data.

This report includes maps generated by the kriging technique that illustrate hydrologic conditions in the Ogallala aquifer, the principal source of water in west-central Kansas. Maps of the aquifer, using a 3-year average, include the 1979-81 water-table altitudes (sheet 1 of 4), the 1979-81 saturated thicknesses (sheet 3 of 4), and the percentage changes in saturated thickness from 1950 to 1979-81 (sheet 4 of 4). A map showing errors of estimate (sheet 2 of 4) also is provided as a measure of reliability for the 1979-81 water-table altitudes.

AVERAGE 1979-81 WATER-TABLE ALTITUDES

A map of water-table altitudes in the Ogallala aquifer was constructed by using annual measurements from a network of observation wells to interpolate estimated values at the center of each 1-mile section. As specified by the Management District, a 3-year moving average of the annual water-level measurements, made in mid-winter, was used to minimize the local effects of seasonal pumping from the observation well or from nearby wells. Thus, estimated 1979-81 water-table altitudes were plotted at the center of each section, and contours were computer-drawn based on that data.

Average 1979-81 water-table altitudes in the Management District range from about 3,720 feet in the west to about 2,580 feet in the east. The gradient of the water table generally averages about 12 feet per mile. A few local depressions in the water-table surface indicate that intensive pumpage for irrigation may have temporarily altered the general gradient.

CONVERSION FACTORS

For those readers who may prefer to use the metric system rather than the inch-pound units used in this report, the conversion factors for the International System (SI) of Units are listed below:

To convert from inch-pound units	To SI units	Multiply by
foot	meter	0.3048
mile	kilometer	1.609
foot per mile	meter per kilometer	0.1894

AVERAGE 1979-81 WATER-TABLE ALTITUDES
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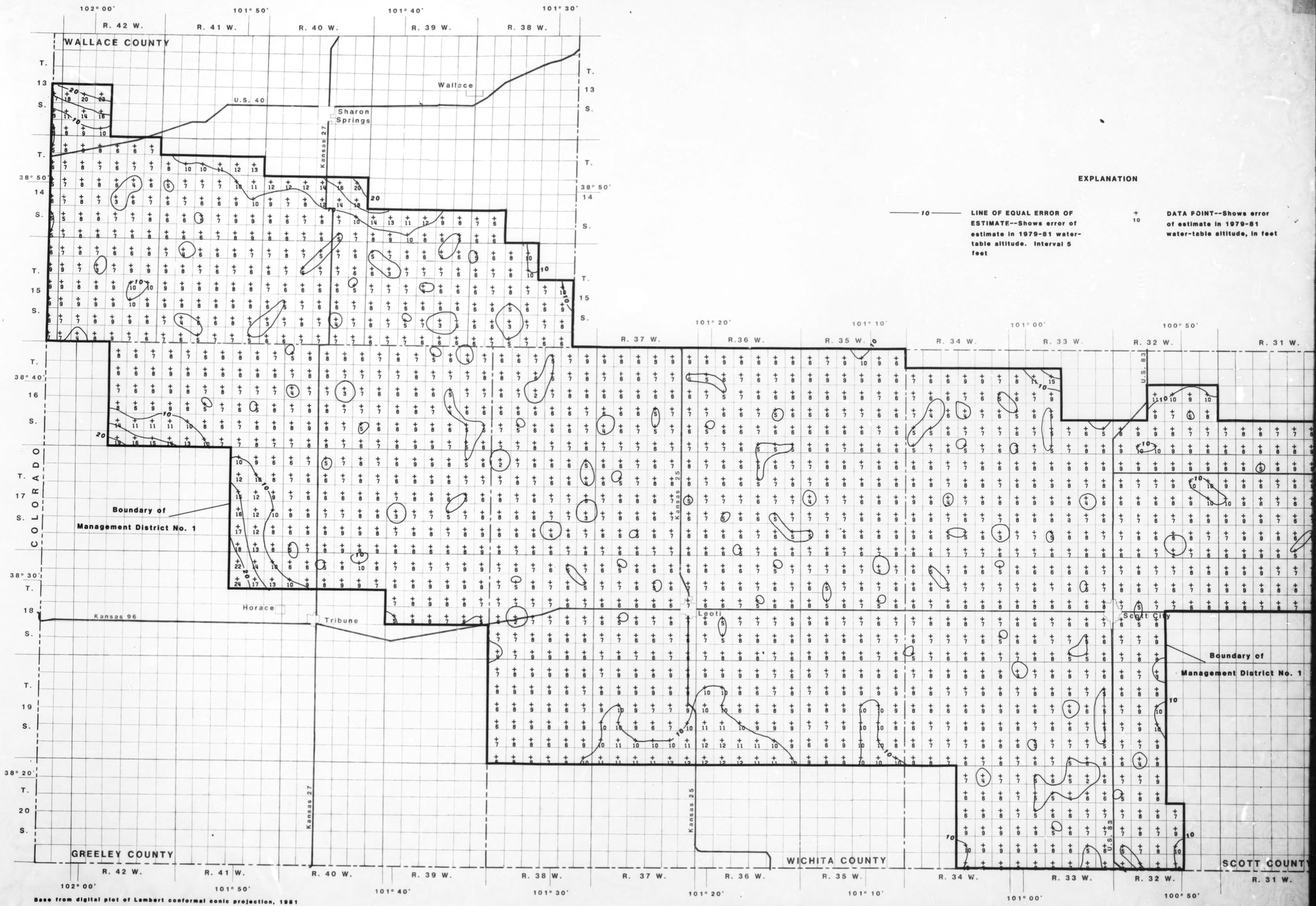

Base from digital plot of Lambert conformal conic projection, 1961

EXPLANATION

10 — LINE OF EQUAL ERROR OF ESTIMATE--Shows error of estimate in 1979-81 water-table altitude. Interval 5 feet

+ 10 DATA POINT--Shows error of estimate in 1979-81 water-table altitude, in feet

ERRORS OF ESTIMATE IN 1979-81 WATER-TABLE ALTITUDES

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EXPLANATION

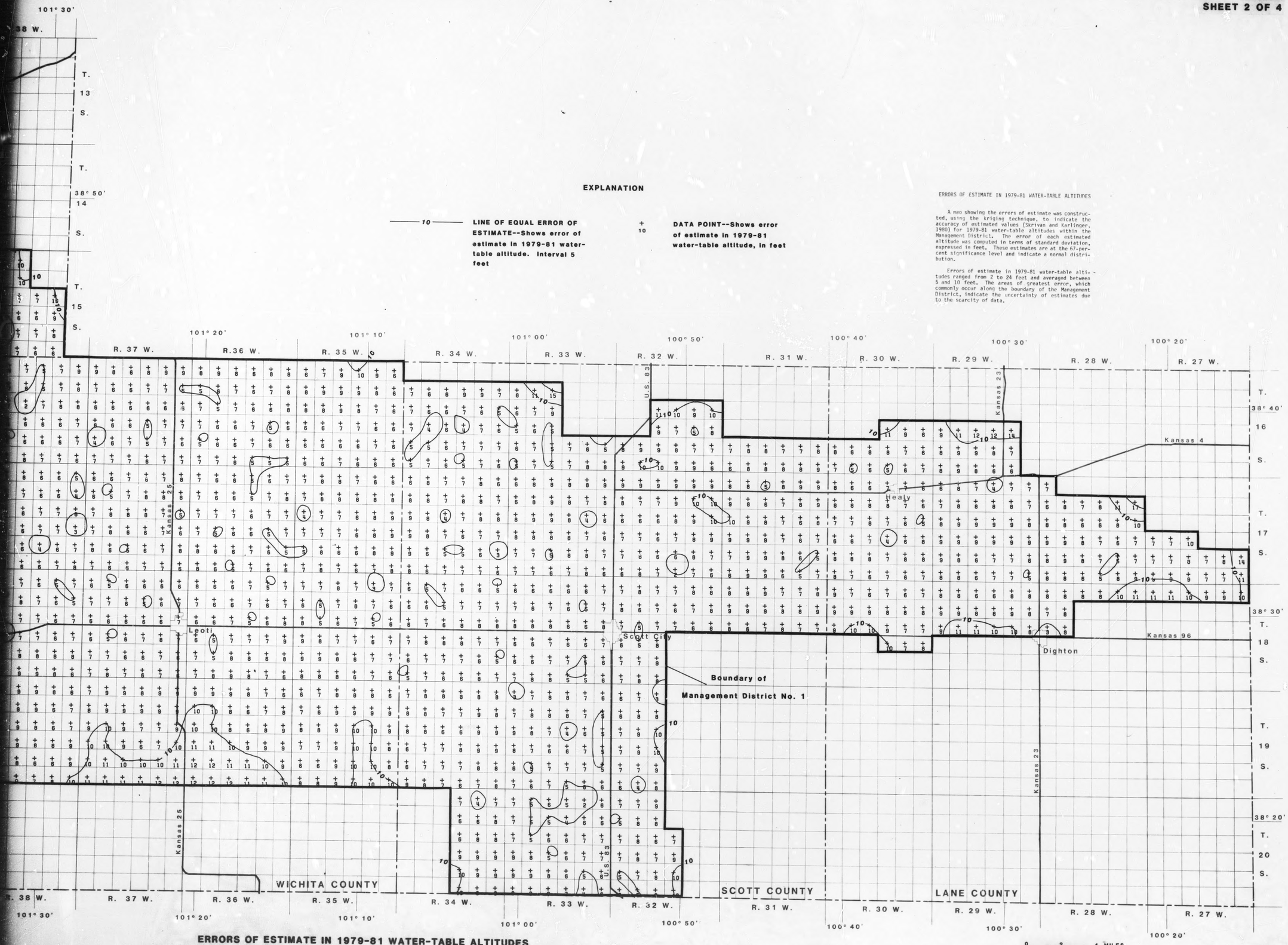
10 — LINE OF EQUAL ERROR OF ESTIMATE--Shows error of estimate in 1979-81 water-table altitude. Interval 5 feet

+ 10 DATA POINT--Shows error of estimate in 1979-81 water-table altitude, in feet

ERRORS OF ESTIMATE IN 1979-81 WATER-TABLE ALTITUDES

A map showing the errors of estimate was constructed, using the kriging technique, to indicate the accuracy of estimated values (Skrivan and Karlinger, 1980) for 1979-81 water-table altitudes within the Management District. The error of each estimated altitude was computed in terms of standard deviation, expressed in feet. These estimates are at the 67-percent significance level and indicate a normal distribution.

Errors of estimate in 1979-81 water-table altitudes ranged from 2 to 24 feet and averaged between 5 and 10 feet. The areas of greatest error, which commonly occur along the boundary of the Management District, indicate the uncertainty of estimates due to the scarcity of data.



ERRORS OF ESTIMATE IN 1979-81 WATER-TABLE ALTITUDES

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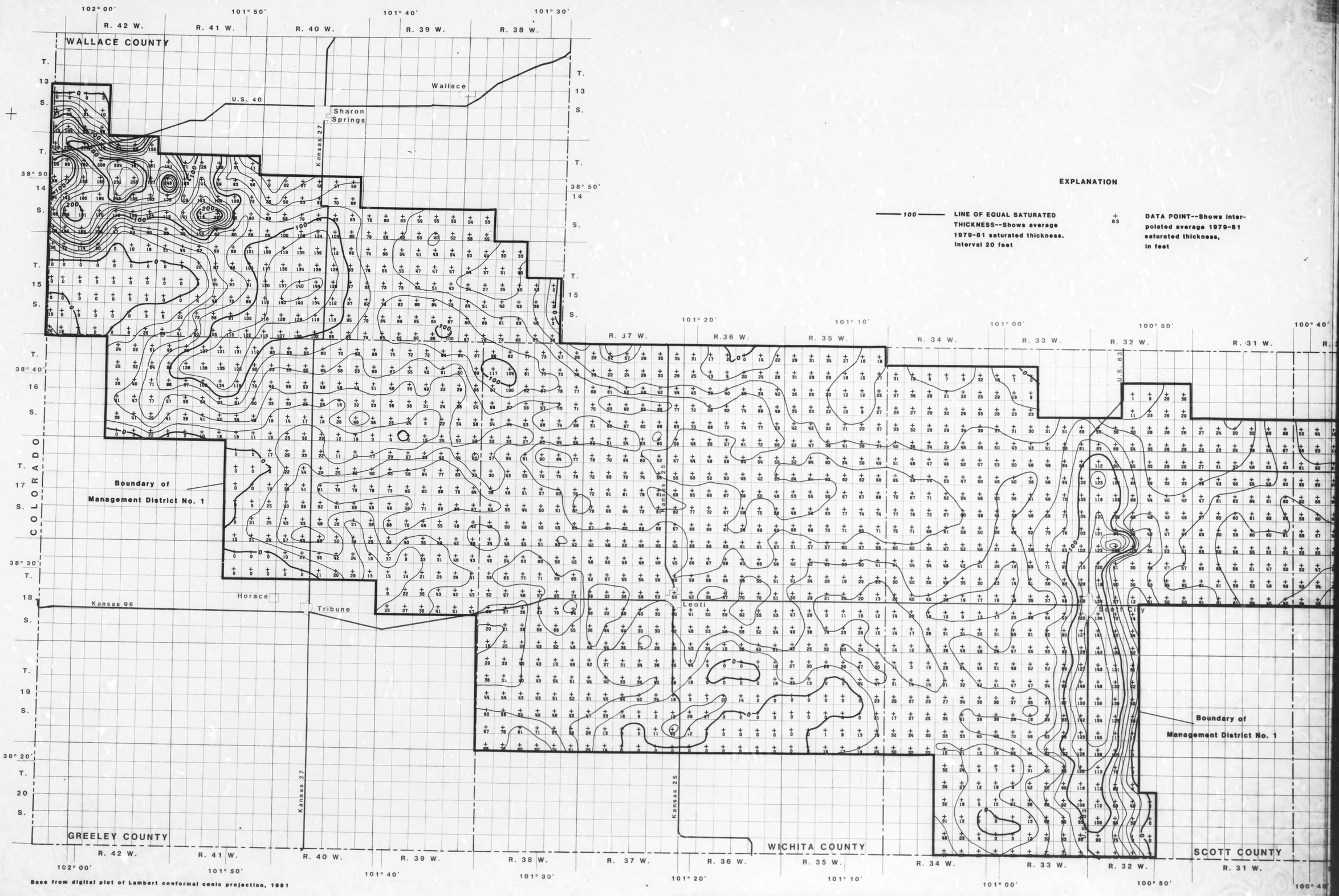


EXPLANATION

100 — LINE OF EQUAL SATURATED THICKNESS--Shows average 1979-81 saturated thickness. Interval 20 feet

+ 63 DATA POINT--Shows interpolated average 1979-81 saturated thickness, in feet

Base from digital plot of Lambert conformal conic projection, 1981

AVERAGE 1979-81 SATURATED THICKNESS OF THE OGALLALA AQUIFER

HYDROLOGIC MAPS OF OGALLALA AQUIFER, WEST-CENTRAL KANSAS, 1979-81

By
Joseph M. Spinazola

1982

Prepared in cooperation with the
WESTERN KANSAS GROUNDWATER MANAGEMENT DISTRICT NO. 1

OPEN-FILE REPORT 82-258
SHEET 3 OF 4

EXPLANATION

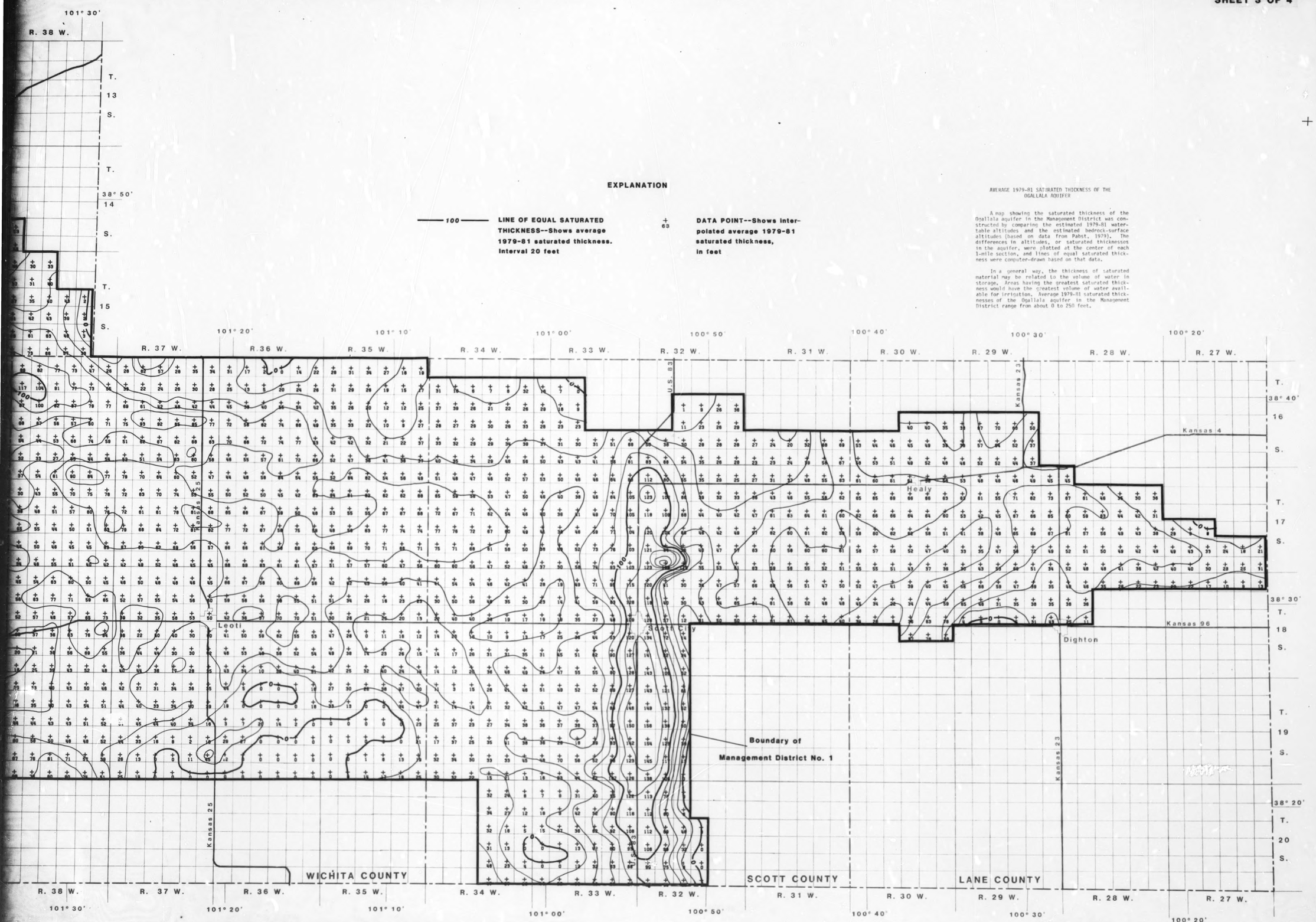
100 — LINE OF EQUAL SATURATED THICKNESS--Shows average 1979-81 saturated thickness. Interval 20 feet

+ 63 DATA POINT--Shows interpolated average 1979-81 saturated thickness, in feet

AVERAGE 1979-81 SATURATED THICKNESS OF THE OGALLALA AQUIFER

A map showing the saturated thickness of the Ogallala aquifer in the Management District was constructed by comparing the estimated 1979-81 water-table altitudes and the estimated bedrock-surface altitudes (based on data from Pabst, 1979). The differences in altitudes, or saturated thicknesses in the aquifer, were plotted at the center of each 1-mile section, and lines of equal saturated thickness were computer-drawn based on that data.

In a general way, the thickness of saturated material may be related to the volume of water in storage. Areas having the greatest saturated thickness would have the greatest volume of water available for irrigation. Average 1979-81 saturated thicknesses of the Ogallala aquifer in the Management District range from about 0 to 250 feet.



AVERAGE 1979-81 SATURATED THICKNESS OF THE OGALLALA AQUIFER

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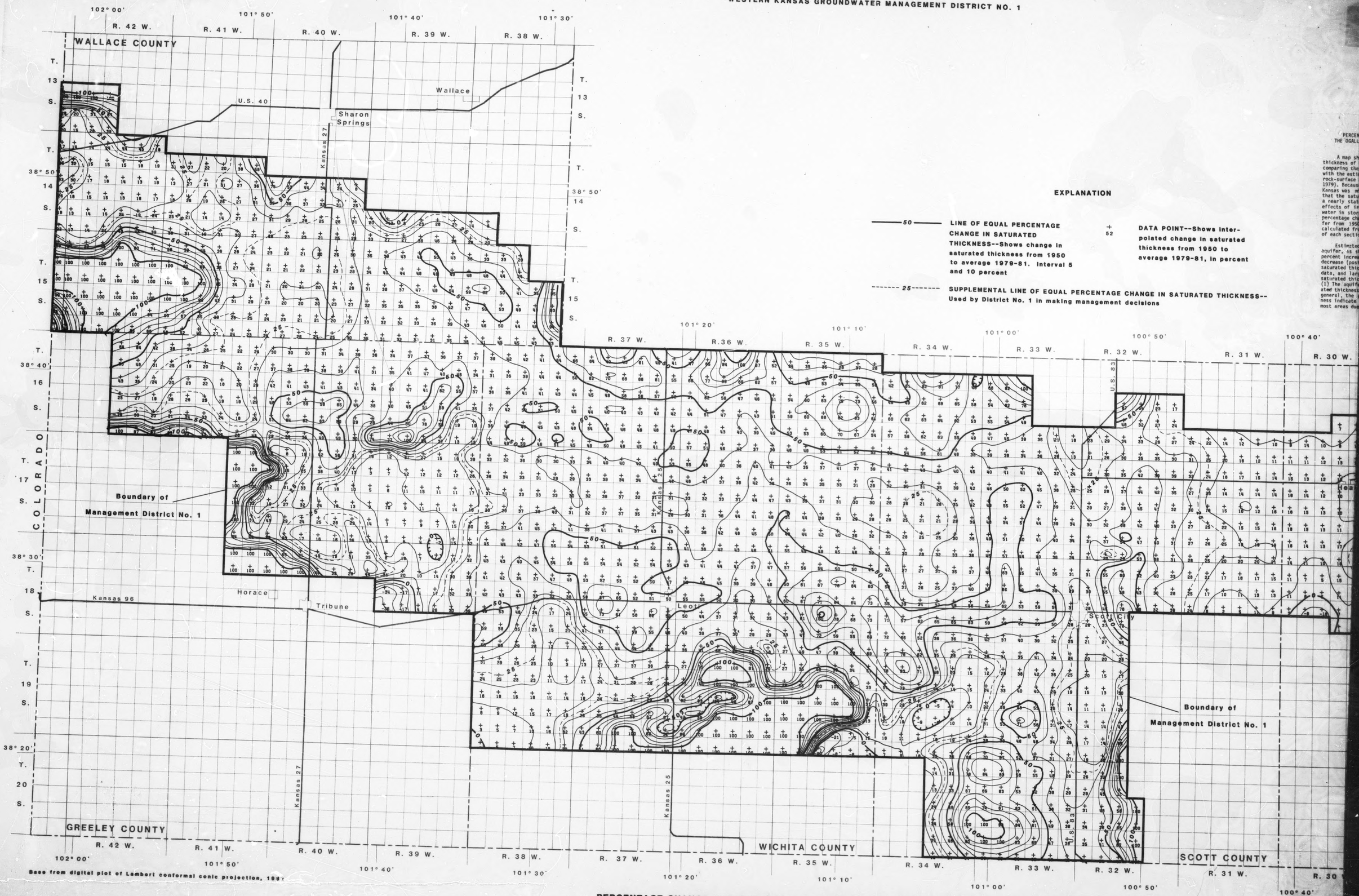

Base from digital plot of Lambert conformal conic projection, 1927

EXPLANATION

—— 50 —— LINE OF EQUAL PERCENTAGE CHANGE IN SATURATED THICKNESS--Shows change in saturated thickness from 1950 to average 1979-81. Interval 5 and 10 percent

+ 52 DATA POINT--Shows interpolated change in saturated thickness from 1950 to average 1979-81, in percent

------ 25 ------ SUPPLEMENTAL LINE OF EQUAL PERCENTAGE CHANGE IN SATURATED THICKNESS--Used by District No. 1 in making management decisions

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PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE OGALLALA AQUIFER, 1950 TO AVERAGE 1979-81

HYDROLOGIC MAPS OF OGALLALA AQUIFER, WEST-CENTRAL KANSAS, 1979-81

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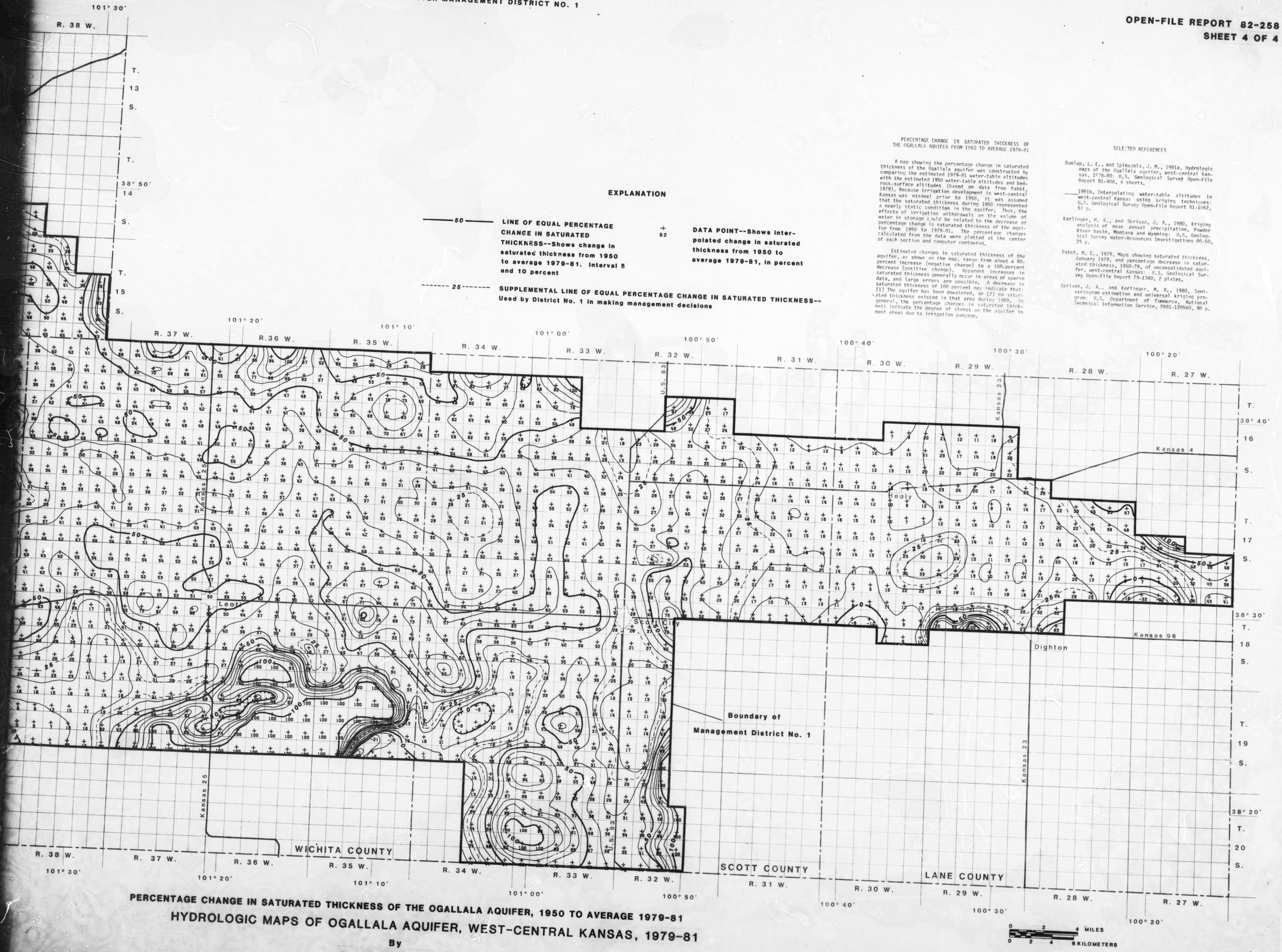

EXPLANATION

—50— LINE OF EQUAL PERCENTAGE CHANGE IN SATURATED THICKNESS--Shows change in saturated thickness from 1950 to average 1979-81. Interval 5 and 10 percent

+52 DATA POINT--Shows interpolated change in saturated thickness from 1950 to average 1979-81, in percent

------25------ SUPPLEMENTAL LINE OF EQUAL PERCENTAGE CHANGE IN SATURATED THICKNESS--Used by District No. 1 in making management decisions

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE OGALLALA AQUIFER FROM 1950 TO AVERAGE 1979-81

A map showing the percentage change in saturated thickness of the Ogallala aquifer was constructed by comparing the estimated 1979-81 water-table altitudes with the estimated 1950 water-table altitudes and bedrock-surface altitudes (based on data from Pabst, 1979). Because irrigation development in west-central Kansas was minimal prior to 1950, it was assumed that the saturated thickness during 1950 represented a nearly static condition in the aquifer. Thus, the effects of irrigation withdrawals on the volume of water in storage could be related to the decrease or percentage change in saturated thickness of the aquifer from 1950 to 1979-81. The percentage changes calculated from the data were plotted at the center of each section and computer contoured.

Estimated changes in saturated thickness of the aquifer, as shown on the map, range from about a 40-percent increase (negative change) to a 100-percent decrease (positive change). Apparent increases in saturated thickness generally occur in areas of sparse data, and large errors are possible. A decrease in saturated thickness of 100 percent may indicate that: (1) The aquifer has been dewatered, or (2) no saturated thickness existed in that area during 1950. In general, the percentage changes in saturated thickness indicate the degree of stress on the aquifer in most areas due to irrigation pumpage.

SELECTED REFERENCES

Dunlap, L. E., and Spinazola, J. M., 1981a, Hydrologic maps of the Ogallala aquifer, west-central Kansas, 1978-80: U.S. Geological Survey Open-File Report 81-908, 4 sheets.

———1981b, Interpolating water-table altitudes in west-central Kansas using kriging techniques: U.S. Geological Survey Open-File Report 81-1062, 51 p.

Karlinger, M. R., and Skrivan, J. A., 1980, Kriging analysis of mean annual precipitation, Powder River basin, Montana and Wyoming: U.S. Geological Survey Water-Resources Investigations 80-50, 25 p.

Pabst, M. E., 1979, Maps showing saturated thickness, January 1979, and percentage decrease in saturated thickness, 1950-79, of unconsolidated aquifer, west-central Kansas: U.S. Geological Survey Open-File Report 79-1340, 2 plates.

Skrivan, J. A., and Karlinger, M. R., 1980, Semivariogram estimation and universal kriging program: U.S. Department of Commerce, National Technical Information Service, PB81-120560, 90 p.

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE OGALLALA AQUIFER, 1950 TO AVERAGE 1979-81

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